

Application No. 10/828,646
Response dated Dec. 30, 2004
Reply to Office Action of October 1, 2004

REMARKS

In the Office Action dated October 1, 2004, claims 1 -10 were rejected under 35 USC § 103(a) as being unpatentable over Sukegawa et al. (U.S. Patent Publication No. 2003/0056751) in view of Urushihara et al. (U.S. Patent Publication No. 2001/0045200).

Claim 1, which is directed toward a fuel injection control device of a diesel engine in which fuel injected into a combustion chamber is ignited after a pre-mixing period has elapsed following a completion of an injection of the fuel, recites means for determining a target pre-mixing period on the basis of engine operating conditions, means for detecting an actual pre-mixing period, and means for adjusting a pre-mixing period of the fuel so that the actual pre-mixing period approaches the target pre-mixing period. Claim 8, which is directed towards a fuel injection control method for a diesel method, contains similar recitations.

Sukegawa discloses a method for controlling the timing of compression ignition of a self-ignited premixed combustion engine. It appears that Sukegawa teaches measuring the peak pressure of the cylinder to determine ignition timing [paragraph 0113].

Urushihara discloses a feedback control for split injection and two-stage combustion of an engine cylinder. It appears that Urushihara discloses a combustion event indicative (CEI) sensor, such as a pressure sensor indicative of variation of cylinder pressure, wherein a signal from the CEI sensor is processed to determine an actual value of a characteristic parameter representative of the combustion event and injection logic modifies at least one of the operating parameters to decrease the deviation between the actual value of the characteristic parameter and the target value [paragraph 0050].

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According to the Examiner, Sukegawa teaches a pre-mixture type of compression ignition in which a pressure sensor determines peak pressure of the cylinder, compares it to a desired peak pressure and adjusts the fuel injection timing accordingly. The Examiner further states that Sukegawa fails to explicitly disclose means for detecting an actual pre-mixing period, but that actual pre-mixing period detection is implicitly taught since the ECU of Sukegawa uses the start of combustion to determine the timing of fuel injection. Further, according to the Examiner, Urushihara teaches that it is known to monitor the start of combustion by using maximum cylinder pressure.

We disagree that the combination of Sukegawa and Urushihara render the present invention obvious. As discussed below, the pre-mixing period of the present application is not the same as the period between fuel injection initiation and ignition initiation, which is taught by Sukegawa. The actual pre-mixing period is the period of time from the completion of fuel injection to ignition—thus, the actual pre-mixing period, as recited in claims 1 and 8, is based on more than just the timing of fuel injection and the timing of ignition. Both Sukegawa and Urushihara merely disclose adjustment means for simply adjusting ignition (start combustion) timing based on fuel injection initiation. Unlike the inventions of claims 1 and 8, Sukegawa and Urushihara fail to disclose adjusting a pre-mixing period so that an actual pre-mixing period approaches a target pre-mixing period.

The technical matter of controlling the pre-mixing period is different from that of controlling the ignition timing. This is because the pre-mixing period varies in accordance with the fuel injection timing, the fuel injection period, the fuel injection pressure, and fuel characteristics or the like. Consequently, it is impossible to control the pre-mixing period by only adjusting the ignition timing.

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Moreover, in the diesel engine, even if the fuel injection quantities are the same, the injection pressure of the fuel is changed if the engine rotational speeds are different. As a result, if the fuel injection quantities are the same, but the engine rotational speeds are different, fuel injection periods are also different. In other words, even if the fuel injection quantities are the same, the fuel injection period becomes longer if the injection pressure of the fuel is low. Conversely, if the injection pressure of the fuel is high, the fuel injection period becomes shorter.

As a consequence, in the diesel engine, if the fuel injection quantities are the same, but the injection pressures of the fuel and the fuel injection periods become different, thereby aspects of the injected fuel will be changed. Consequently, even if the fuel injection quantities are the same, the period of time from the completion of fuel injection to ignition varies. In other words, its pre-mixing period varies.

Furthermore, the fuel for a diesel engine (diesel oil) does not evaporate as easily as gasoline does. Since the diesel oil takes a certain period to evaporate and mix with the air after completing the fuel injection, it is important to control the pre-mixing period.

It is highly advantageous for a diesel engine that performs a pre-mixing combustion to adjust a pre-mixing period in order to decrease the exhaust emission. In view of the above, it is highly advantageous to determine a target pre-mixing period and an actual pre-mixing period and adjust a pre-mixing period such that the actual pre-mixing period approaches the target pre-mixing period in order to compensate for the change (rather than just control an ignition timing based on a fuel injection timing).

Applicant submits that the rejection of claims 1 and 8 under § 103 are improper as neither the Sukegawa publication nor the Urushihara

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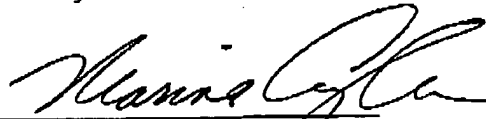
publication, alone or in combination, teach or suggest each and every limitation of the claims. Claims 2-7 and 9-10 depend from claims 1 and 8 and include additional recitations thereto. Therefore, for at least the reasons discussed above, these claims are not obvious in light of the cited prior art.

Applicant submits that all pending claims are allowable and respectfully requests favorable reconsideration of these claims.

Although Applicant does not believe a fee is due with the submission of this Response, if it is deemed that a fee is required, please charge to Deposit Account 13-0235.

Respectfully submitted,

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